The Impact of Hurricanes Katrina, Rita and Wilma On Business Establishments: A GIS Approach[1]

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ABSTRACT

We use Geographic Information System tools to develop estimates of the economic impact of disaster events such as Hurricane Katrina. Our methodology relies on mapping establishments from the Census Bureau's Business Register into damage zones defined by remote sensing information provided by FEMA. The identification of damaged establishments by precisely locating them on a map provides a far more accurate characterization of affected businesses than those typically reported from readily available county level data. The need for prompt estimates is critical since they are more valuable the sooner they are released after a catastrophic event. Our methodology is based on pre-storm data. Therefore, estimates can be made available very quickly to inform the public as well as policy makers. Robustness tests using data from after the storms indicate our GIS estimates, while much smaller than those based on publicly available county-level data, still overstate actual observed losses. We discuss ways to refine and augment the GIS approach to provide even more accurate estimates of the impact of disasters on businesses.

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Introduction

Large scale disasters, such as Hurricanes Katrina, Rita and Wilma, pose two broad measurement challenges to statistical agencies. First, the public and policymakers want accurate estimates of the social and economic impacts of storms such as these and other types of disaster events (e.g., earthquakes, floods etc). For example, how many people are displaced? How many businesses are damaged or destroyed? How much economic output will be lost?

Moreover, data users will want this information very soon after the disaster. In order to provide timely data, statistical agencies typically provide existing, or new custom tabulations of pre-storm data on the affected areas. These data products are almost always provided at the county-level. However, business and housing units within an affected county will not all sustain damage and those that do will not be affected in the same way.

Second, how does the disaster event impact the data collection and processing activities of statistical agencies such as the Census Bureau? For example, will displacement from the storm affect the ability of survey participants to respond? If units (household or businesses) fail to respond, how can we determine whether the unit should be removed from the survey frame due to inactivity, or whether the unit's inactivity is only temporary? More simply, how does a statistical agency distinguish nonresponse due to the disaster event from more mundane reasons, such as going out of business?

Addressing both these broad classes of disaster related measurement issues requires that statistical agencies be able to identify which business and household units are impacted by the event. In this paper, we first address how to identify business units affected by the hurricanes of 2005. We use Geographic Information Systems (GIS) tools to merge information on areas affected by the 2005 hurricanes to the Census Bureau's Business Register (BR). We then classify business establishments by Federal Emergency Management Administration (FEMA) damage categories.

Once this is done, it's fairly straightforward to determine the number and activity level of business establishments affected by the hurricanes. However, GIS methods can't be used for establishments for which the Census Bureau lacks accurate and sufficiently detailed geocodes. In these cases we develop a straightforward and easily implemented imputation methodology to develop estimates of the number of affected establishments and their employment and payroll.[4]

A key advantage in our approach to measuring the impact of disasters on businesses is that it can be used to generate estimates very quickly after the event. The interest in such estimates declines rapidly. Thus, measurement strategies that require statistical agencies to wait for new administrative or survey data will produce estimates for which there is little public interest. Our approach provides statistical agencies, like the Census Bureau,

[4] We would also like to look at sales, but survey information on sales is not available for the frequency and level of geographic detail required for these purposes.

with the means to provide the public and decision makers with reliable estimates when they need them.

Our GIS approach can provide important and timely information to those responsible for collecting and processing survey and administrative data to aid them in understanding the impact of disasters like hurricanes on their statistical programs. While relatively little was done along these lines at the Census Bureau during the 2005 hurricane season, we are working on developing protocols that could be utilized in the future.

A key characteristic of our GIS based approach is that it yields more modest estimates of disaster related damage than do tabulations of county level data that are commonly reported. To examine the accuracy of our approach, we perform robustness tests using post-disaster data from the 4th quarter of 2005. Our robustness analysis suggests the realized impacts on business establishments of the 2005 hurricane is even more limited than implied by our GIS based estimates. This suggests further calibration of our GIS methodology.

Determination of Affected Establishments

Hurricane damage does not equally affect all parts of a political jurisdiction such as a state or county. In addition, the issuance of a federal disaster declaration for a county does not require that the county suffer a large amount of damage.[5] Estimates based on the federal disaster designation will lead us to overstate the impact of such events. Ideally we want to precisely delineate what businesses are located in affected areas and then measure their output, employment and so on.

The use of GIS can accomplish the first part of this task – determining which businesses are located within an affected area. FEMA makes available, shortly after each hurricane, detailed PDF maps and ESRI shape files of affected areas based on remote sensing data.[6] In the case of Katrina, the remote sensing observations were obtained over the period from August 30 to September 10, 2005.

FEMA codes the affected areas using the following damage categories:

- Limited Damage: Generally superficial damage to solid structures (e.g., the loss of tiles or roof shingles), some mobile homes and light structures are damaged or displaced.
- Moderate Damage: Solid structures sustain exterior damage (e.g., missing roofs or roof segments), some mobile homes and light structures are destroyed, and many are damaged or displaced.
- Extensive Damage: Some solid structures are destroyed, most sustain exterior damage (e.g., roofs are missing, interior walls are exposed), most mobile homes and light structures are destroyed.

[5] Code of Federal Regulations (**Title 44, Chapter 1, Part 206.48**) establishes that a county is eligible for public assistance if it has countywide damages of at least $2.77 per capita.
[6] Those for hurricane Katrina are available at http://www.gismaps.fema.gov/2005pages/rsdrkatrina.shtm.

- Catastrophic Damage: Most solid and all light or mobile structures are destroyed.
- Flooded area: Area under water.
- Undamaged: Areas not covered by the above categories.

Figure 1 presents two views of the areas of Louisiana damaged by hurricane Katrina. The left panel depicts Louisiana parishes classified as federal disaster areas. The panel on the right shows the areas given one of the above FEMA damage classifications. One is immediately struck by the difference in the land area labeled as affected under the two methodologies. Note, however, that FEMA does not classify undeveloped areas, so the area classified in one of the above FEMA categories must be, by definition, smaller than under the method of classifying an entire parish/county as damaged. Nevertheless, for our purposes of measuring the impact on businesses, we are bound to find fewer businesses in the affected areas depicted in the right panel than in the left.

The next step is to assign establishments in the Census Bureau's Business Register (BR) a FEMA damage classification. The BR contains the universe of business establishments with paid employees and contains basic information about the scale and type of business activity at each location. Thus, placing an accurate damage classification on each establishment in affected states would give an accurate enumeration of the number and scale of activity at affected businesses.

Our approach is to use GIS tools to geocode businesses in the BR and then add FEMA GIS damage layers. Doing this gives us, for each (geocoded) establishment, the FEMA damage classification of the location containing the establishment. Critical to this approach are: 1) the accuracy of the FEMA damage classifications, 2) the availability and accuracy of detailed geocodes on the BR, and 3) the timeliness of business data at our disposal.

On the first point, there is not much we can do. We take the FEMA GIS information as given. As you will see, in some cases FEMA may provide alternative estimates of the type of damage sustained at a given location. In the case of hurricane Katrina, FEMA provided two sets of GIS flood layers for New Orleans which showed significantly different patterns. From other information (e.g., news accounts, conversations with people in New Orleans), we have reason to suspect that the GIS data showing more limited flooding was more accurate. As you will see, our robustness analysis bears this out. Nevertheless, we compute and present estimates under both scenarios.

The ability to place businesses within FEMA-designated affected areas depends on the completeness and accuracy of the geocodes available on the BR. The lowest unit of geography on the BR that is reliable for the entire universe of establishments is the county or parish. Many establishments also have valid census block and tract codes. Our initial attempt to merge FEMA GIS damage data to Census Bureau business data was to map census blocks into FEMA damage areas. However, this proved too cumbersome as many blocks intersected with multiple damage areas (e.g., part of the block was flooded and part was undamaged). This resulted in a very large number of establishments that could not be assigned a unique FEMA damage classification.

More accurate establishment-level geocodes permit assigning BR establishments to a unique FEMA damage area. To accomplish this, we used street address information on the BR to assign latitude and longitude (lat/long) coordinates to as many establishments as possible.[7] Our ability to do this is dependent on the quality of the address information on the BR. This varies across space somewhat. Address quality (as measured by whether we can assign a lat/long coordinate) in the BR is higher for establishments in urban areas than it is for those in rural areas. Thus, for the three states affected by hurricane Katrina, we are able to assign detailed geocodes to between 61 percent (Alabama) and 73 percent (Louisiana) of the establishments in the BR.

Another shortcoming of the process by which we geocoded establishments stems from the fact that, by using street address, we are only able to locate each business on a point on the map rather than delineate the polygon defined by the establishment's physical boundaries. We have no information about the extent of the business properties, the locations of buildings or other things that might help determine what lies inside a damage zone and what doesn't. This is probably not too problematic for small establishments, but could be troublesome for large establishments such as oil refineries.

Finally, the time required to collect, process and ready data for analysis necessarily dictates the type of analysis that can be conducted. Survey data on current business activity (from, for example, the Manufacturer's Shipments, Inventories and Orders Survey and Monthly Retail Survey) are unsuitable for estimating the impact of localized events, such as hurricanes, as their samples are designed to provide national estimates only. Thus, very few survey units would be expected to be located in affected areas. In contrast, administrative data provide universal coverage. Administrative data have a lag time of approximately one quarter, but still require considerable processing before they are useful for statistical and analytic uses. Thus, the only way to produce timely estimates of the impact of disaster events such as hurricanes is to use what's available at the time of the event. Hurricane season reaches its peak in the late summer. In the case of the Census Bureau, the most recently fully processed data from the BR will be for the reference year 2 years prior. Prior year BR data will also be available but not yet fully processed.[8] Administrative data that have undergone only minimal processing are typically available for the period two quarters prior to an event.

Measuring the Impact on Business Establishments

If all establishments were accurately geocoded on the Census Bureau's Business Register, assessing the potential impact using FEMA GIS damage layers would be a fairly straightforward exercise. Namely, one simply determines which establishment

[7] We used ArcGIS to attach latitude and longitude coordinates to BR street addresses.

[8] Administrative data are not available at the establishment-level for multi-location companies. The Census Bureau's Annual Survey of Manufactures (ASM) and Company Organization Surveys (COS) are used to collect establishment-level information during years without an Economic Census. The Economic Census collects establishment-level data every five years. All these programs are used to update the BR. Importantly, for measuring the impact of hurricanes, the ASM/COS updates to the BR occur in the fall of the year after the reference year.

units are located within FEMA damage GIS polygons and then use information on the Business Register and other Census Bureau datasets to examine their characteristics.

As mentioned above, however, not all establishments on the Business Register have geocodes of the precision required to locate them accurately on a map. Depending on location (particularly urban vs. rural settings), between 27 percent and 39 percent of establishments will not have detailed (lat/long) geocodes. In these cases we are not able to accurately determine their location. Fortunately, most of the FEMA damage areas lie in areas where the BR contains better address information.

Because of the uncertainty introduced by missing geocodes, we develop a range of damage estimates. At the bottom of this range, we only count as damaged those business establishments that we are able to locate inside FEMA damage zones using GIS. At the top end of this range, we assume that all businesses in counties and parishes receiving federal disaster area designations with missing geocodes are also damaged.

Neither of these alternatives is satisfactory. Therefore, we employ a simple strategy that uses the share of geocoded businesses in a given county or parish that lie within a FEMA damage area to impute the total for the county. We can compute this since all establishments are geocoded to the county level and we know how many we are able to give latitude and longitude coordinates. We multiply those shares with the number (or employment or payroll) of un-geocoded businesses. More precisely, for a given characteristic x (e.g, number of establishments, employees, payroll), the imputed total located within areas with FEMA damage classification d ($d \in$ {undamaged, limited, moderate, extensive, catastrophic, flooded}) is given by

$$(1) \qquad x_c^d = \frac{x_{gc}^d}{x_{gc}} x_{\sim gc} + x_{gc}^d$$

where c denotes the county, g denotes the total computed by summing across geocoded establishments, and $\sim g$ denotes the total computed by summing across ungeocoded establishments.

GIS Based Estimates of the Impact of Hurricanes Katrina, Rita and Wilma

Recall that one of our main goals is to develop a measurement strategy that can provide estimates of the impact of disasters on business establishments very quickly after the event. An implication of the need for timely estimates is that it requires us to use data from before the storm. In this case, we use data from the 2004 snapshot files of the Census Bureau's Business Register (BR) to provide an assessment of lost activity due to damage from the hurricanes.[9] The earliest the Census Bureau would obtain updates of

[9] This paper reports on a refined version of our initial methodology developed in the fall of 2005. At that time we utilized the 2003 BR as the Census Bureau had not yet completed processing of the version of the annual snapshot data brought to CES for analytical purposes. These initial estimates can be seen at http://www.census.gov/econ/www/hurricane/maps/hurricane_katrina_map_tables.htm. In the future,

administrative data covering the period after the hurricanes (i.e., the 4th quarter of 2005) was early 2006. The demand for estimates of the impact of the storms on businesses and the economy was immediate, and waiting until early 2006 to provide those estimates would mean they would be of little use.

To see the utility of our GIS approach, we examine the impact of hurricane Katrina on business establishments in Alabama, Louisiana and Mississippi. The BR has three items of interest in measuring the impact of the storm: number of affected establishments, employment at affected establishments, and payroll at affected establishments. Note that our analysis does not attempt to estimate the cost to businesses of physical damage from the storms. Nor does it factor in secondary effects on undamaged businesses that might arise from storm-related labor shortages or a lack of customers due to large scale and persistent evacuations (although these secondary impacts will be picked up by our robustness analysis). Our goal is to simply estimate the impact on businesses due to damage sustained in the storm. These estimates can then be used to help determine the overall impact of the storm on the economy of the region and nation.

Our most basic results are given in Table 1. The three panels, A B and C, look respectively at the percent of establishments, employment, and payroll at geocoded businesses that was affected by hurricane Katrina for the states of Louisiana, Mississippi, and Alabama. Table 1 shows the level of damage implied using alternative definitions of affected areas. In the case of Louisiana we provide two sets of estimates, since FEMA has two alternative GIS estimates of the scope of the flooding in New Orleans.[10] These can be seen in Figure 2. The blue shaded area uses the FEMA GIS data indicating the maximum extent of flooded area. We denote this New Orleans Flood Definition I. The orange shaded area uses the FEMA GIS data indicated less extensive flooding (it excludes areas where flood waters receded quickly). We refer to this as New Orleans Flood Definition II.

Recall that we can't determine the type of damage sustained by ungeocoded businesses. Thus, the table shows results only for the subset of the data for which we were able to assign latitude/longitude coordinates, thereby allowing us to determine the type of damage sustained from the storm. All results are expressed as a percent of state totals. We report similar tables for hurricanes Rita and Wilma in the appendix.

The main result of Table 1 is that employing crude levels of geography vastly overstates the direct impact of the storm on businesses. This makes common sense and most people would likely understand that just because a county or parish receives a federal disaster declaration, not every home and business has been affected. Nevertheless, these are precisely the types of estimates one sees from the news media and statistical agencies soon after the storm. Over 70 percent (row 1, panel A) of the geocoded establishments in

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however, we would most likely make use of more current quarterly updates to the BR in order to get the most recent data possible.

[10] We use the files dated September 10 and September 11. The first describes the maximum extent of damage inflicted by Katrina. The second describes receded flooding as of September 11 and appears to more accurately describe the extent of flooding in the city of New Orleans.

Louisiana and Mississippi, the two hardest hit states, are located within counties or parishes that received a federal disaster declaration (these shares also hold true for ungeocoded establishments).

One issue could be that many counties and parishes receive federal disaster declaration, but sustain little damage. If we use the presence of a FEMA damage area within a county or parish, as we do in the second row of table 1, to denote affected counties and parishes, we see the percentages of businesses, employment, and payroll affected by the storm drop dramatically. This is particularly true for Mississippi where the share of affected businesses drops from 70.5 to just under 15 percent (row 2, panel A).

The percentage of affected businesses is reduced even further when using smaller geographic units such as census blocks. However, the most accurate method is to use only those establishments located in areas that are known to be damaged.[11] These provide our lower bound estimates in that they only include those establishments that are directly observed in a FEMA damage zone. The rows in Table 1 labeled "In FEMA GIS Disaster Map" give the percentage of geocoded businesses, their employees and payroll, that we identified as being located inside a FEMA damage polygon.

Depending on what GIS source data we use, we find that between 5.9 and 18.5 percent of geocoded businesses in Louisiana lie within affected areas. These establishments account for between 6.2 and 21.0 percent of employment and between 7.1 and 23.7 percent of payroll at geocoded establishments in Louisiana. We also report the percent of establishments located within FEMA damage areas by damage classification. The primary class of damage sustained by Louisiana businesses is flooding followed by "limited" damage.

Mississippi also sustained heavy damage from Katrina. We identified 7.0 percent of geocoded businesses in Mississippi as being located within affected areas. These businesses accounted for 7.2 of employment and 6.7 percent of payroll at geocoded Mississippi businesses. Most interestingly, the predominant type of damage sustained by businesses in Mississippi was "catastrophic". Table 1B (last row, third column) shows that 4.4 percent of the employees at geocoded establishments in Mississippi worked at establishments that sustained "catastrophic" damage..

Table 1 contrasts the number, employment and annual payroll of alternative estimates of affected business establishments obtained using alternative level of geographic precision to determine which establishments are located in areas receiving storm damage. At one extreme are the estimates implied by assuming that all businesses located in a federally declared disaster county or parish are affected by the storm. Again, this is the methodology implicit in most widely published estimates released by the media and statistical agencies shortly after disaster events. At the other extreme are the estimates obtained from our GIS approach where we only classify as damaged those establishments

[11] Again, if there are damaged establishments located outside of FEMA GIS damage areas, we will not know they are damaged.

that we know are located in areas listed as damaged by FEMA – our lower bound GIS estimates.

A problem with the lower bound estimates, however, is that they assume all ungeocoded establishments in the Census Bureau's register are undamaged. To address this problem we use the imputation formula given in equation (1) to compute the number of ungeocoded establishments that were damaged by the storm. We believe that this is the best method to obtain accurate estimates of damage to business quickly after a disaster event. Alternatively one can simply assume that all ungeocoded businesses are damaged. We refer to this methodology as the upper bound GIS based estimate.

We report our best GIS based estimate, as well as the upper and lower bound GIS based estimates in Table 2. For convienience we also report the county/parish based and lower bound GIS estimates from Table 1 in Table 2. Consider first estimates of the number of affected business establishments given in the upper panel of Table 2. Depending on which FEMA New Orleans flood data are used, we see that even our upper bound GIS estimate of between 50,000 and 60,000 affected establishments is still far below the 131,000 establishments located in federally declared disaster declared counties/parishes in AL, LA and MS (roughly 51 percent of all establishments in those states). However, just as not all geocoded businesses are affected by the storms, not all ungeocoded businesses will be affected. Our imputation rule give in equation (1), assume the same proportion of ungeocoded establishments will be damaged as that for geocoded establishments. Applying these imputes gives us our "best" GIS bases estimates. Use this imputation strategy and the broad FEMA New Orleans (NOLA) flood definition (def. I), we see that 23,149 establishments sustained direct damage from hurricane Katrina. Using the narrow FEMA flood definition (def. II) yields about 10,300 establishments directly affected by Katrina. The imputed "best" GIS estimates are much closer to our lower bound estimates that they are to the upper bound estimates, which are much smaller that that implied using county level data.

In terms of payroll, Table 2 shows that the reduction in the magnitudes is similar. Establishments in LA, MS, and AL that lie inside FEMA disaster declared counties/parishes are responsible for approximately $60 billion worth of annual payroll (roughly 53 percent of all payroll in those states). Using our "best" estimates and the broad FEMA definition (def. I), we see that establishments that were directly affected by Katrina are responsible for approximately $12 billion in annual payroll. Using the narrow FEMA definition (def. II) yields about $3.1 billion in annual payroll at affected business establishments.

The estimates shown in Tables 1 and 2 could be generated by statistical agencies, such as the Census Bureau, very quickly. Once FEMA releases remote sensing GIS data, analysts at the statistical agency can download the shape files and merge them with geocoded data on businesses (or housing units). In the case of the Census Bureau, this is most easily done with the Business Register. This of course requires that detailed geocodes be maintained on the BR. This is not currently the case. Discussions are

underway to have the Census Bureau's Geography Division provide latitude and longitude coordinates for as many establishments in the BR as possible.[12]

Robustness Tests and Calibration

We now turn to an analysis of the robustness and accuracy of our GIS based estimates of disaster related damage to businesses. We are concerned with several potential sources of error. First, the FEMA GIS damage layers could be inaccurate. Next, detailed geocoded on the Census Bureau's Business Register can either be missing or inaccurate. Finally, in the case of quantities such as payroll or sales, our GIS methodology gives the impact on annual rates. The impact of the storm on most businesses is likely to be of considerably shorter duration. Thus, if we want accurate estimates of the impact on business payrolls or sales (not considered in this paper), we may need to develop a method to estimate the duration of a disaster's impact.

The Census Bureau has no direct way to assess the accuracy of the GIS damage classifications made available by FEMA. In the case of the impact on business establishments, it is possible, however, to use administrative data on the Census Bureau's business register to examine quarterly business payrolls before and after the hurricanes hit.[13] Our measurement strategy is to use a simple regression model to compare one year growth in quarterly payroll across establishments located in affected and unaffected areas, and to compare affected establishments before and after the hurricanes. We use data for all the Gulf States and include damage from hurricanes Katrina, Rita and Wilma. We specify the following regression model:

$$(2) \qquad \gamma_{it} = X_i\beta + \varepsilon_{it}$$

where the dependent variable is the annual growth rate of quarterly payroll given by

$$(3) \qquad \gamma_{it} = \frac{pay_{it} - pay_{it-4}}{.5*(pay_{it} + pay_{it-4})},$$

and X_i is a matrix of dummy variables indicating the class of damage sustained by establishment i from the hurricanes. The FEMA damage classifications refer to particular locations. So in essence, the X variables are simply location dummies. The regressions will compare the performance of establishments located in locations with different FEMA damage designations. We use the quarterly administrative payroll data in the BR to measure pay_{it} as the payroll for establishment i in quarter t.

In addition, we run the regressions for all quarters in 2005 so that we can compare the performance of establishments within a given FEMA damage classification before and

[12] The Census Bureau goes to much greater effort to geocode housing units than it does for business establishments. This is because the Census Bureau releases tabulations of household data at detailed levels of geography from the decennial census and does not for businesses due to disclosure concerns.
[13] Again, we would prefer to use a metric like sales, but it is not available on a quarterly basis.

after the hurricanes. This requires quarterly payroll data for all establishments in each of the Gulf States for 2004 and 2005. These we obtain from the BR.

For the dependent variable, $\gamma_{it,}$ we employ the growth rate definition used in Davis, Haltiwanger, and Schuh (1996) and given in equation (3). This specification has several advantages for our purposes. First, it is robust to entry and exit allowing an integrated treatment of establishment births, deaths, and continuers. Since it's likely that many businesses will not report payroll at all in the third or fourth quarters of 2005, this feature is quite appealing. Also, this specification controls for seasonal effects by using year to year changes in payroll rather than quarter to quarter.

Note that the growth rate specification given by (3) implies that births will have value of 2 and deaths will have a value of -2. We expect to find that many establishments in the harder hit areas will not report payroll in the 4^{th} quarter of 2005 since they may be shut down. So it could be that the distribution of fourth quarter one year payroll growth rates will be skewed to the left (i.e., toward -2). However, we are also interested in seeing the impact of the hurricanes on businesses that don't shut down. For that reason, we estimate regressions on the all establishment sample and the continuers only sample separately.

Since we are ultimately interested in the impact of the hurricanes on the economy at large, we estimate weighted regressions where each establishment is weighted by its average payroll over the 2004 and 2005 reference years. This means we are giving each dollar of payroll equal weight, rather than each establishment. Thus, larger establishments will receive more weight. Finally, we also estimate the one year payroll growth regressions under both of the New Orleans flood damage estimates provided by FEMA.

The results using the broad definition of flooding in New Orleans are given in Table 3, and those using the narrow definition are given in Table 4. We define the regressors such that the estimated coefficients are interpreted as the weighted mean one year change in quarterly payroll for each geographical classification. These geographic classifications describe the level of damage sustained by the 2005 hurricanes.

Tables 3 and 4 provide a rich description of the outcomes of Gulf Coast state establishments by class of hurricane damage. We first compare establishments located within federally declared disaster counties to those that weren't. The first column of coefficients gives the growth rates for establishments outside of affected counties/parishes. The remaining columns have the same information for various classes of establishments located within affected counties/parishes. Comparisons across rows highlight differences by quarter.

The first two rows of tables 3 and 4 compare the one year growth in quarterly payroll for the first and second quarters of 2005, respectively. The main finding here is that there are no large and systematic differences between establishments located in areas affected by the hurricanes and those that weren't in the two quarters *before* the first hurricane (Katrina) hit. If anything, businesses located in the areas affected by the hurricanes were

enjoying more growth (in payroll) prior to the storms, than were businesses located in areas unaffected by the storms. First quarter payroll was 4.8 percent higher in 2005 than 2004 for businesses located outside of federally declared disaster counties/parishes. Businesses located within undamaged areas of affected counties/parishes had either 6.6 or 6.2 percent increases in first quarter payroll depending on whether we use the broad (def. I) or narrow (def. II) definitions of flooding in New Orleans. Business located in FEMA damage areas experienced one year first quarter payroll growth between -7.4 percent and 10.9 percent (using the regression for Flood Def. II in table 4). The damaged areas are fairly small and contain between approximately 100 and 10,000 establishments depending on the damage classification. This explains why we see such varied outcomes for these classes.

We can also compare establishments within affected counties/parishes that lie in areas FEMA classified as undamaged to those that lie within damaged areas. The third column of coefficients gives the weighted mean one year payroll growth rates for establishments located in undamaged areas within affected counties. Columns four through eight provide the coefficients for establishments located in one of the FEMA classified damage areas. Note that we provide a separate set of coefficient estimates for ungeocoded (i.e., where we can't identify the type of damage sustained) establishments located in affected counties/parishes. This allows us to assess the impact on areas we know are and are not affected cleanly.

Hurricane Katrina occurred in the third quarter of 2005 and is partly reflected in the Q3 regressions in Tables 3 and 4. All the damaged areas show sharply reduced growth in quarterly payroll, both relative to undamaged and unaffected areas, and relative to their own performance from the prior quarters. Comparing the growth rates for damaged businesses in the "all businesses" regressions for Q2 and Q3 in table 4 (i.e., subtract the Q3 growth rate from the Q2 growth rate), we see that business establishments experienced between a 3.6 and 15.7 percent reduction in payroll growth.

Turning to the regressions reported in the bottom half of Tables 3 and 4, we find that continuing businesses do not exhibit a reduction in Q3 payroll growth. Thus, the reductions in payroll growth observed for damaged areas in Q3 are coming from establishments that close immediately following hurricane Katrina or those that fail to report 3rd quarter payroll to the Internal Revenue Service (IRS) that supplies administrative data that underlie the BR.

The shortcomings of using quarterly payroll as our measure of impact become apparent at this point. Many businesses may have kept payrolls near normal levels even though sales were affected. There are several reasons they might do this including the expectation that business conditions would return to normal shortly, or to retain skilled workers.[14] Since we don't have quarterly sales data for a large enough sample of Gulf State businesses, we have no choice but to use payroll.

[14] This is more likely the case in industries with high proportions of high skilled labor.

The Q4 regressions show the dramatic drop in payrolls for damaged areas. Moreover, the severity of the drop appears to be related to the extent of the damage. Due to the small number of businesses observed in areas that sustained "extensive damage" the estimated coefficients for this category are never significant. Therefore, we will limit our discussion to the other damage categories. Looking at the "all businesses" regressions that capture the impact of businesses that close due to the storms, we see that businesses located in areas with "limited", "moderate" and "catastrophic" damage suffer reductions in payrolls of 16, 27 and 45 percent, respectively, in 2005:Q4 relative to 2004:Q4. Thus, businesses in areas that FEMA GIS data show more severe damage suffer greater economic impacts. This finding gives us confidence that our GIS approach is a useful method to ascertain the impact of disasters on businesses.

Businesses in the broader flooded area (flood def. I) in New Orleans experienced a 32 percent reduction in payroll. Those in the smaller flooded area suffered a 49 percent decrease in payrolls relative to the same period one year prior. This finding indicates that FEMA GIS data showing more limited flooding better reflects the actual damage suffered from hurricane Katrina in New Orleans since the many unflooded businesses under definition I brought the estimated impact down.

Even if we look at continuing businesses, we see large impacts from the storms in the Q4 regressions. Payrolls for continuing businesses in areas sustaining limited damage are not significantly different in 2005:Q4 than they were for 2004:Q4. Using the limited flood definition (def II – table 4), we see that businesses in areas that experienced "moderate" and "catastrophic" damage had reductions in payroll of 4.6 and 21.5 percent, respectively. Those in flooded areas had a 15 percent drop in payrolls relative to the same period a year before.

Comparing the results for all businesses to those for continuing establishments only suggests that much of the impact of the hurricanes on businesses occurs at those that cease operations. Again, if we had data on sales, we might find that continuers suffered more extensive losses and are simply trying to retain their employees in expectation of improved business conditions. Also, some of the businesses that closed due to the storms might re-open after some period. We plan to continue to examine subsequent quarters of data for the Gulf States to see if this does indeed occur.

We can use the estimated coefficients to compute an estimate of the total impact on business payrolls of the storms. To do this, we simply multiply the coefficients of the Q4 regression in table 3 for each of the classifications in federally declared disaster counties/parishes net of the coefficient for unaffected areas outside these counties/parishes by their total quarterly payroll in 2004:Q4. Doing this shows a loss of $715 million in payroll for the 4th quarter of 2005 due to the storms with most of this due to Katrina. The total impact will depend on the amount of time the effects of the storms persist. We will continue to track establishments in the affects areas to determine the length of impact and to see if areas sustaining more severe damage require more time to recover.

If we annualize the payroll impact, we estimate with data received after the storms, we get a figure of $2.86 billion for all three storms. We can compare with estimates from the GIS methodology described above using pre-storm data. Recall the lower bound estimate for hurricane Katrina using the narrow (Def. II) definition of flooded area in New Orleans was $2.1 billion. The lower bound estimate for hurricanes Rita and Wilma available from the appendix tables is approximately $1.1 billion. Thus, the lower bound estimate for all three storms is about $3.2 billion – the annual payroll of establishments we observe inside FEMA damage areas. We refer to this number as the lower bound. However, for it to be realized all the businesses in damaged areas would need to shut down. Clearly the actual impact on individual businesses will depend on the level of damage actually sustained. Those with limited damage may bounce back quite easily. Our regression results suggest the actual losses suffered by businesses are 10.6 percent lower than our lower bound estimates.

Finally, we can construct a crude estimate of business revenues lost due to the storms. The Economic Census is the only economy-wide source of establishment-level data on business revenues. It's conducted only every five years with the last one performed for reference year 2002 and, therefore, not timely for our purposes. We can, however, construct revenue to payroll ratios that can be used to re-scale our payroll based impact estimates. To do this, we computed a payroll weighted average of revenue to payroll ratios across 2-digit NAICS sectors. This results in economy-wide revenue to payroll ratio of approximately 5.7. Thus, our lower bound GIS based estimate suggests that the business revenue lost due to hurricanes Katrina, Wilma, and Rita in the 4th quarter of 2005 would be just over $4.5 billion ((3.2/4)*5). Similarly rescaling the 4th quarter payroll impact estimate from the regressions in Table 4 gives an estimate of lost revenue of just over $4 billion.

These estimates are close to similar estimates developed using different methodologies. Burton and Hicks (2005) estimated that Hurricane Katrina would result in $4.6 billion in lost business revenue using a regression based approach and publicly available Census data. This compares to our estimates of $3 and $4.4 billion in 4th quarter Katrina related business revenue losses based on our GIS-based lower bound and best (imputed) estimates, respectively. Thus, our imputation methodology is very close to the regression based estimates of Burton and Hicks. However, our results using realized 4th quarter payrolls suggest a more limited impact.

With estimates of the total cost of hurricane Katrina alone ranging between $100 and $200 billion, it's clear that cost associated with lost business revenues and payrolls are not a major component. The largest impact on business establishments is most likely to be physical damage to structures and equipment. Burton and Hicks (2005) estimate this to be approximately $21.1 billion for commercial structures and $36.4 billion for commercial equipment for Katrina. These amount to just over a third of their $156.7 billion estimate for total Katrina related damages. Unfortunately, we don't have data on capital stocks at the establishment level that would allow us to assess estimates of losses of structures and equipment.

Conclusions

In this paper, we outlined a GIS based method that combines FEMA remote sensing information with Census Bureau Business Register files to determine which business establishments are affected by disaster events such as hurricanes. We also provide a methodology to estimate the number of employees and the payrolls at affected establishments. Economic Census data is used to estimate business revenue lost due to disasters.

Importantly, estimates based on our GIS approach are more accurate and potentially of much greater utility to the public and decision makers than tabulations of data at the state or county level that often appear in the media and on statistical agency websites following disasters. Further, the approach can be used for any type of disaster but its applications are much broader than that. Expanded GIS capabilities would greatly enhance the value of the data collected and processed by statistical agencies. In particular, statistical agencies would be able to better assess the impact of disasters on their ongoing statistical programs. Perhaps more importantly, expanded GIS capabilities would make possible a wide range of new estimates and analyses.

We tested the accuracy of the GIS based estimates using simple regressions to see if businesses affected by hurricane Katrina, Rita and Wilma experienced less growth in payroll relative to unaffected businesses. We found that affected business had similar patterns of one year payroll growth to unaffected for the first three quarters of 2005. For the fourth quarter of 2005, however, affected establishments showed much lower one year payroll growth rates. Moreover, the estimated impacts of the storms using data from after the storms data were fairly close to our GIS based estimates using pre-storm data.

Finally, we caution that our GIS based estimates provide a measure of the effect on economic activity that result from the impact of the hurricanes on business establishments. Estimates of the total impact on business activity require post-event data such as we used in the regressions in tables 3 and 4 that give the impact for the 4^{th} quarter of 2005. The longer term impact cannot be determined at this point and will depend on the speed of recovery and relocation. We plan to follow establishments in the Gulf States in order to determine when and if establishments in affected areas recover or if indeed activity picks up in undamaged areas as a result of large-scale relocations.

References

Davis, Steven J., John Haltiwanger and Scott Schuh, 1996, *Job Creation and Destruction*, MIT Press.

Burton, Mark L. and Michael J. Hicks, 2005 "Hurricane Katrina: Preliminary Estimates of Commercial and Public Sector Damages." Center for Business and Economic Research.

FEMA Remote Sensing Information for Hurricane Katrina can be found at http:/www.gismaps.fema.gov/2005pages/rsdkatrina.shtm

Figure 1

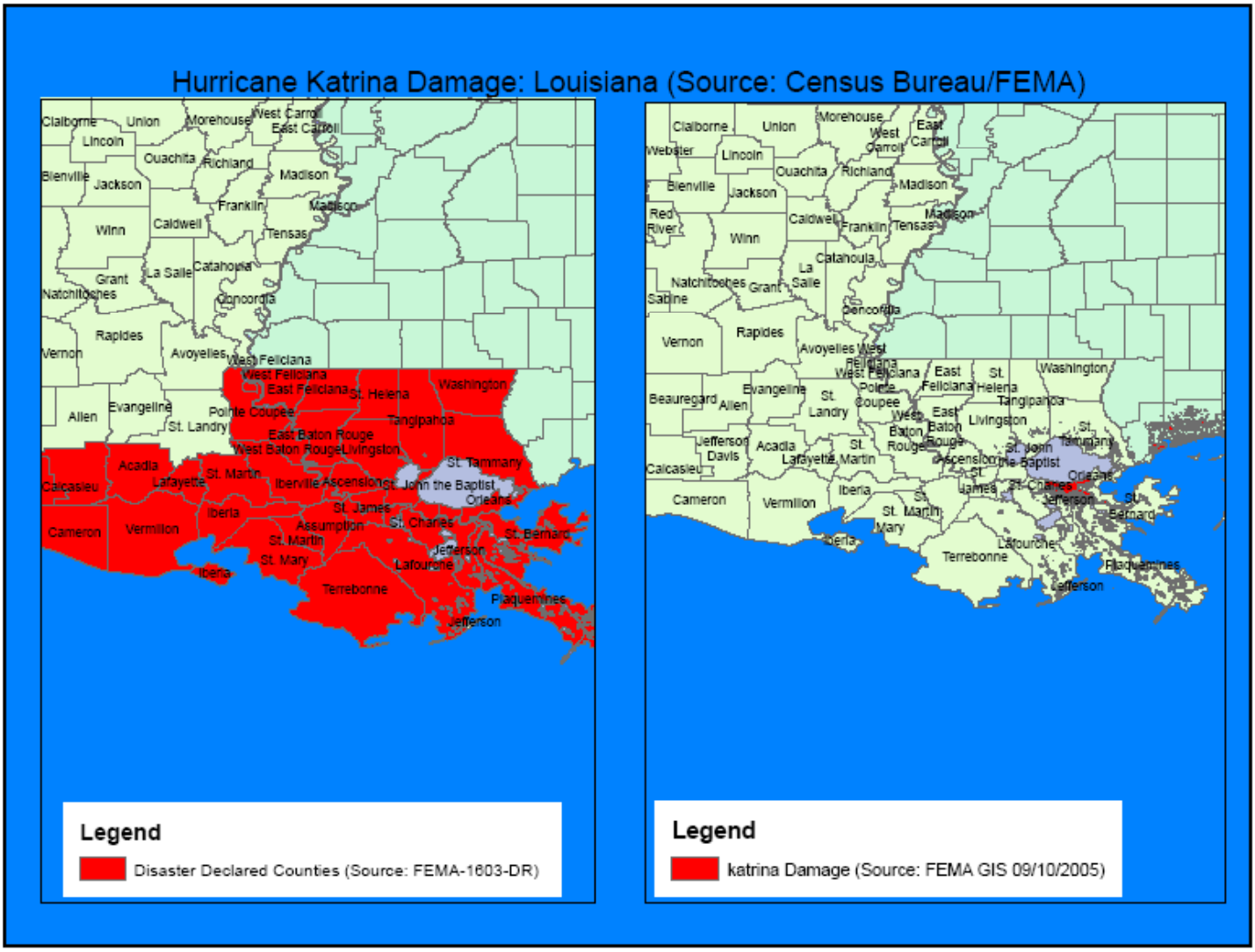
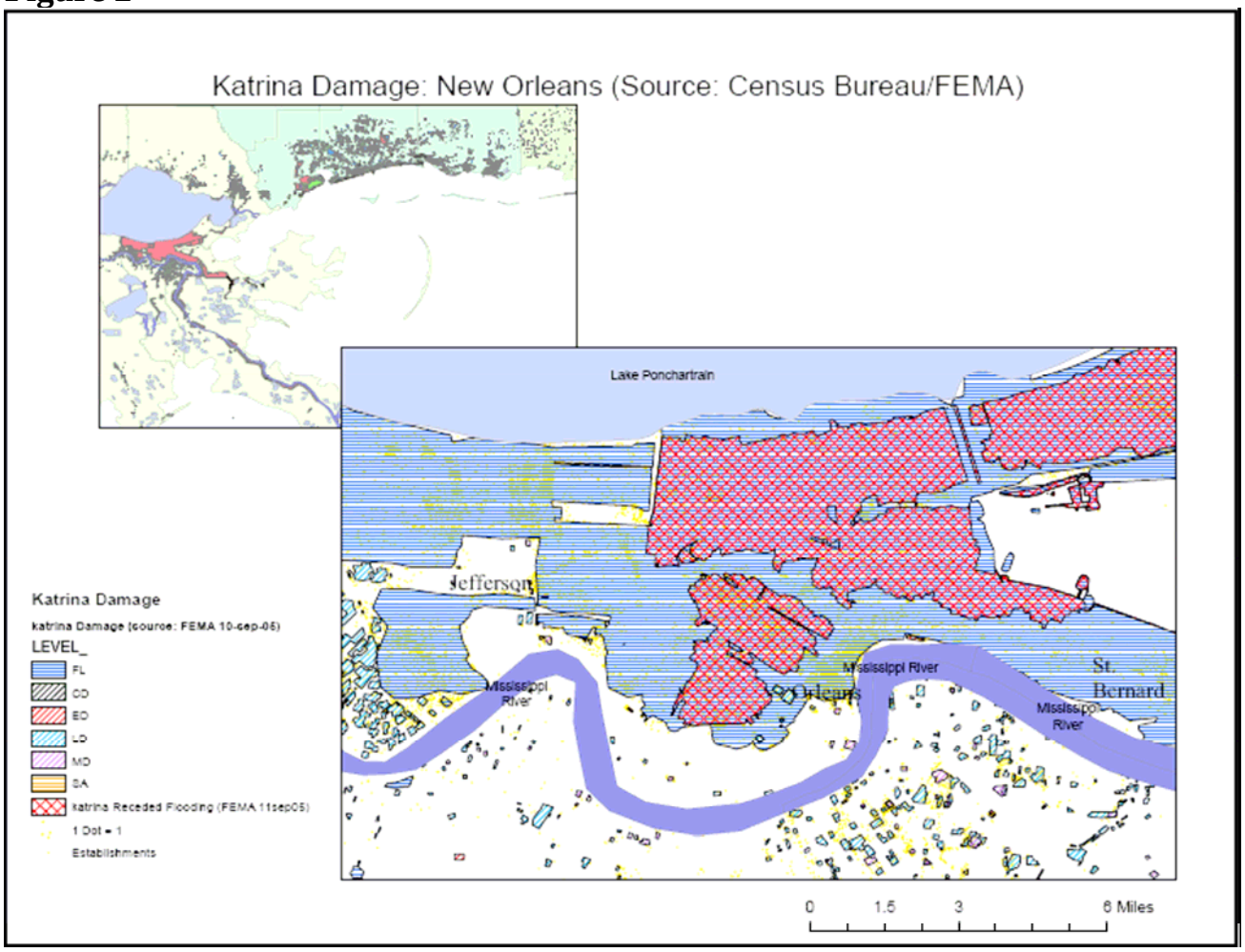

Hurricane Katrina Damage: Louisiana (Source: Census Bureau/FEMA)
Legend
Disaster Declared Counties (Source: FEMA-1603-DR)
Legend
katrina Damage (Source: FEMA GIS 09/10/2005)

Figure 2



Notes: FL=Flooded, CD=Catastrophic Damage, ED=Extensive Damage, MD=Moderate Damage, LD=Limited Damage, SA=Saturated Area.

Table 1A: Number of Business Affected by Katrina: by Type of Area (Geocoded establishments only)

	Louisiana I	Louisiana II	Mississippi	Alabama
Number of Businesses	107,277		62,090	100,841
Number of Geocoded Businesses	75,518		38,538	61,429
In FEMA disaster declared Counties/Parishes [0]	73.39%	73.39%	70.51%	18.40%
In Counties/Parishes with some FEMA Damage Area	40.68%	35.95%	14.81%	13.65%
In Affected MSA/Place (%) [2]	32.12%	32.12%	14.03%	11.19%
In Affected Census Blocks (%) [3]	22.31%	12.13%	12.22%	1.76%
In FEMA GIS Disaster Map	18.49%	5.92%	7.01%	0.10%
FEMA Classification - Flooded	16.15%	3.58%	0.07%	0.00%
FEMA Classification - Limited Damage	2.16%	2.16%	2.81%	0.08%
FEMA Classification - Moderate Damage	0.14%	0.14%	1.29%	0.01%
FEMA Classification - Extensive Damage	0.02%	0.02%	0.17%	0.01%
FEMA Classification - Catastrophic Damage	0.02%	0.02%	2.67%	0.00%
FEMA Classification - Mixed [4]	0.00%	0.00%	0.00%	0.00%

0. As of 10/05/2005
1. As reported by Wikipedia on 09/08/2005
2. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
3. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.
4. This is not a FEMA classification. Part of the Block is FEMA classified.

Table 1B: Number of Employees Affected by Katrina: by Type of Area (Geocoded establishments only)

	Louisiana	Louisiana II	Mississippi	Alabama
Number of Employees	1,599,043		886,206	1,566,910
Number of Geocoded Employees	1,100,735		540,796	921,506
In FEMA disaster declared Counties/Parishes [0]	75.72%	75.72%	69.94%	16.99%
In Counties/Parishes with some reported death (%) [1]	53.38%	37.57%	44.33%	0.05%
In Affected MSA/Place (%) [2]	34.59%	34.59%	15.32%	11.25%
In Affected Census Blocks (%) [3]	25.43%	14.42%	12.44%	1.69%
In FEMA GIS Disaster Map	21.03%	6.20%	7.22%	0.05%
FEMA Classification - Flooded	18.27%	3.44%	0.03%	0.00%
FEMA Classification - Limited Damage	2.64%	2.64%	1.88%	0.05%
FEMA Classification - Moderate Damage	0.10%	0.10%	0.88%	0.00%
FEMA Classification - Extensive Damage	0.01%	0.01%	0.07%	0.00%
FEMA Classification - Catastrophic Damage	0.01%	0.01%	4.36%	0.00%
FEMA Classification - Mixed [4]	0.00%	0.00%	0.00%	0.00%

0. As of 10/05/2005
1. As reported by Wikipedia on 09/08/2005
2. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
3. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.
4. This is not a FEMA classification. Part of the Block is FEMA classified.

Table 1C: Share of Annual Payroll Affected by Katrina: by Type of Area (Only if establishment is coded)

	Louisiana I	Louisiana II	Mississippi	Alabama
Total Payroll (millions)	31,567	31,567	14,038	28,162
In FEMA disaster declared Counties/Parishes [0]	78.35%	78.35%	71.12%	15.56%
In Counties/Parishes with some FEMA Damage Area	44.13%	39.65%	13.81%	11.88%
In Affected MSA/Place (%) [1]	37.63%	37.63%	13.64%	10.63%
In Affected Census Blocks (%) [2]	27.69%	15.01%	11.13%	1.70%
In FEMA GIS Disaster Map	23.68%	7.09%	6.69%	0.03%
FEMA Classification - Flooded	20.17%	3.58%	0.03%	0.00%
FEMA Classification - Limited Damage	3.40%	3.40%	1.75%	0.03%
FEMA Classification - Moderate Damage	0.10%	0.10%	0.83%	0.00%
FEMA Classification - Extensive Damage	0.01%	0.01%	0.06%	0.00%
FEMA Classification - Catastrophic Damage	0.01%	0.01%	4.01%	0.00%

0. As of 10/05/2005
1. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
2. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.

Table 2: Estimates of the Number and Annual Payroll of Business Establishments Affected by Hurricane Katrina

	Number of Affected Establishments	
Located in Federally declared Counties/Parishes	131,172	
	NOLA Flood Def. I	NOLA Flood Def. II
Lower Bound GIS (observed in FEMA GIS damage areas)	16,721	7,229
Best GIS Estimate (Lower Bound + Imputes)	23,149	10,321
Upper GIS Bound (all ungeocoded estabs assumed damaged)	59,999	50,502
	Annual Payroll at Affected Establishments (Billions)	
Located in Federally declared Counties/Parishes	$60.09	
	NOLA Flood Def. I	NOLA Flood Def. II
Lower Bound GIS (observed in FEMA GIS damage areas)	$8.42	$2.08
Best GIS Estimate (Lower Bound + Imputes)	$11.87	$3.11
Upper GIS Bound (all ungeocoded estabs assumed damaged)	$29.41	$23.07

Table 3. One Year Payroll Growth Rate Regressions (by Quarter): NOLA Flood Definition I*

Sample	Annual Change Computed for	Outside Federally Declared County or Parish	Inside Federally Declare County or Parish						
			Un - Gecoded	Geocoded					
				Undamaged	Limited Damage	Moderate Damage	Extensive Damage	Catastrophic Damage	Flooded
A. All Businesses	Q1	0.048	0.064	0.066	0.052	0.108	0.200	0.032	-0.016
		(0.0007)	(0.002)	(0.0017)	(0.015)	(0.036)	(0.098)	(0.021)	(0.006)
	Q2	0.065	0.057	0.094	0.079	0.120	0.109	0.022	0.008
		(0.0007)	(0.002)	(0.0017)	(0.014)	(0.034)	(0.095)	(0.021)	(0.006)
	Q3	0.078	0.056	0.100	-0.024	0.039	-0.030	-0.014	-0.124
		(0.0007)	(0.002)	(0.0017)	(0.014)	(0.034)	(0.096)	(0.021)	(0.006)
	Q4	-0.060	-0.083	-0.053	-0.160	-0.277	-0.104	-0.451	-0.320
		(0.0008)	(0.003)	(0.002)	(0.016)	(0.042)	(0.112)	(0.027)	(0.007)
B. Continuers Only	Q1	0.058	0.095	0.076	0.077	0.067	0.261	0.050	0.011
		(0.0004)	(0.001)	(0.001)	(0.009)	(0.021)	(0.058)	(0.012)	(0.004)
	Q2	0.081	0.097	0.113	0.069	0.092	0.200	0.066	0.042
		(0.0004)	(0.001)	(0.001)	(0.008)	(0.020)	(0.055)	(0.012)	(0.003)
	Q3	0.114	0.117	0.142	0.074	0.090	0.188	0.120	0.031
		(0.0004)	(0.001)	(0.001)	(0.009)	(0.021)	(0.058)	(0.012)	(0.004)
	Q4	0.058	0.067	0.081	0.018	-0.046	0.045	-0.214	-0.067
		(0.0005)	(0.002)	(0.001)	(0.010)	(0.025)	(0.025)	(0.015)	(0.004)

* Standard errors in parentheses. NOLA Flood Defintion 1 refers to FEMA GIS data showing largest area flooded.

Table 4. Annual Payrol Growth Regressions (by Quarter): NOLA Flood Definition II*

Sample	Annual Change Computed for	Outside Federally Declared County or	Inside Federally Declare County or Parish						
			Un - Gecoded	Geocoded					
				Undamaged	Limited Damage	Moderate Damage	Extensive Damage	Catastrophic Damage	Flooded
A. All Businesses	Q1	0.048	0.064	0.062	0.052	0.109	0.200	0.032	-0.074
		(0.0007)	(0.002)	(0.0016)	(0.015)	(0.037)	(0.098)	(0.021)	(0.012)
	Q2	0.065	0.057	0.090	0.008	0.120	0.109	0.022	0.011
		(0.0007)	(0.002)	(0.0017)	(0.014)	(0.034)	(0.095)	(0.021)	(0.012)
	Q3	0.078	0.056	0.089	-0.024	0.039	-0.030	-0.014	-0.146
		(0.0007)	(0.002)	(0.0016)	(0.014)	(0.034)	(0.096)	(0.021)	(0.012)
	Q4	-0.060	-0.083	-0.065	-0.160	-0.276	-0.104	-0.451	-0.485
		(0.0008)	(0.003)	(0.002)	(0.016)	(0.041)	(0.112)	(0.027)	(0.015)
B. Continuers Only	Q1	0.058	0.095	0.074	0.077	0.065	0.261	0.050	-0.053
		(0.0004)	(0.001)	(0.001)	(0.009)	(0.021)	(0.058)	(0.012)	(0.007)
	Q2	0.081	0.097	0.108	0.069	0.092	0.200	0.066	0.056
		(0.0004)	(0.001)	(0.0009)	(0.008)	(0.020)	(0.055)	(0.012)	(0.007)
	Q3	0.114	0.117	0.136	0.074	0.090	0.188	0.120	0.085
		(0.0004)	(0.001)	(0.001)	(0.009)	(0.021)	(0.058)	(0.012)	(0.008)
	Q4	0.058	0.067	0.075	0.018	-0.046	0.046	-0.215	-0.150
		(0.0005)	(0.002)	(0.001)	(0.010)	(0.025)	(0.025)	(0.016)	(0.009)

* Standard errors in parentheses. NOLA Flood Defintion 1 refers to FEMA GIS data showing largest area flooded.

Appendix

Table A-1A: Share or Businesses Affected by Hurricane Rita: by Type of Area (Geocoded establishments only)

	Louisiana	Texas
Total Number of Business Establishments	104,161	497,771
Number of Geocoded Business Establishments	75,521	344,581
In FEMA disaster declared Counties/Parishes [0]	15.77%	5.58%
In Counties/Parishes with some FEMA Damage Area	5.29%	1.58%
In Affected MSA/Place (%) [1]	3.32%	1.64%
In Affected Census Blocks (%) [2]	1.44%	0.95%
In FEMA designated GIS Damage Zone	0.26%	0.13%
FEMA Classification - Flooded	0.01%	0.00%
FEMA Classification - Limited Damage	0.22%	0.07%
FEMA Classification - Moderate Damage	0.03%	0.06%
FEMA Classification - Extensive Damage	0.01%	0.00%
FEMA Classification - Catastrophic Damage	0.00%	0.00%

0. As of 10/28/2005
1. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
2. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.

Table A-1B: Share of Employees Affected by Hurricane Rita: by Type of Area (Geocoded establishments only)

	Louisiana	Texas
Total Number of Employees	1,580,714	8,216,004
Number of Employees at Geocoded Business Establishments	1,100,697	5,404,481
In FEMA d1saster declared Counties/Parishes [0]	13.18%	4.77%
In Counties with some FEMA Damage Area	4.71%	1.50%
In Affected MSA/Place (%) [1]	3.33%	1.56%
In Affected Census Blocks (%) [2]	1.29%	0.96%
In FEMA designated GIS Damage Zone	0.18%	0.13%
FEMA Classification – Flooded	0.01%	0.00%
FEMA Classification - Limited Damage	0.12%	0.08%
FEMA Classification - Moderate Damage	0.01%	0.05%
FEMA Classification - Extensive Damage	0.02%	0.00%
FEMA Classification - Catastrophic Damage	0.01%	0.00%

0. As of 10/28/2005
1. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
2. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.

Table A-1C: Share or Annual Payroll Affected by Hurricane Rita: by Type of Area (Geocoded establishments only)

	Louisiana	Texas
Total Payroll (millions)	47,476	292,169
Total Payroll at Geocoded Business Establishments (millions)	31,567	193,142
In FEMA disaster declared Counties/Parishes [0]	11.97%	4.07%
In Counties/Parishes with some FEMA Damage Area	4.11%	1.24%
In Affected MSA/Place (%) [1]	2.88%	1.29%
In Affected Census Blocks (%) [2]	1.19%	0.74%
In FEMA designated GIS Damage Zone	0.16%	0.11%
FEMA Classification - Flooded	0.03%	0.00%
FEMA Classification - Limited Damage	0.10%	0.07%
FEMA Classification - Moderate Damage	0.01%	0.04%
FEMA Classification - Extensive Damage	0.02%	0.00%
FEMA Classification - Catastrophic Damage	0.01%	0.00%

0. As of 10/28/2005
1. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
2. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.

Table A-2A: Share of Businesses Affected by Hurricane Wilma: by Type of Area
(Geocoded establishments only)

	Florida
Total Number of Business Establishments	421,291
Number of Geocoded Business Establishments	332,156
In Counties Declared as Federal Disaster Area[0]	50.15%
In Counties with at least one FEMA damaged zone	45.22%
In Affected MSA/Place (%) [1]	50.14%
In Affected Census Blocks (%) [2]	4.50%
In FEMA designated GIS Damage Zone	0.58%
FEMA Classification - Saturated	0.00%
FEMA Classification - Limited Damage	0.57%
FEMA Classification - Moderate Damage	0.01%
FEMA Classification - Extensive Damage	0.00%
FEMA Classification - Catastrophic Damage	0.00%

0. As of 10/31/2005
1. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
2. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.

Table A-2B: Share of Employees Affected by Hurricane Wilma: by Type of Area (Geocoded Establishments only)

	Florida
Total Number of Employees	5,657,336
Number of Employees at Geocoded Business Establishments	4,486,114
In Counties Declared as Federal Disaster Area [0]	43.60%
In Counties with at least one FEMA damaged zone	39.70%
In Affected MSA/Place (%) [1]	43.60%
In Affected Census Blocks (%) [2]	5.97%
In FEMA designated GIS Damage Zone	0.49%
FEMA Classification - Saturated	0.00%
FEMA Classification - Limited Damage	0.48%
FEMA Classification - Moderate Damage	0.01%
FEMA Classification - Extensive Damage	0.00%
FEMA Classification - Catastrophic Damage	0.00%

0. As of 10/31/2005
1. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
2. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.

Table A-2C: Share of Payroll Affected by Hurricane Wilma: by Type of Area (Geocoded establishments only)

	Florida
Total Payroll	178,064
Total Payroll at Geocoded Business Establishments (millions)	146,633
In Counties Declared as Federal Disaster Area [0]	43.86%
In Counties with at least one FEMA damaged zone	40.22%
In Affected MSA/Place (%) [1]	43.86%
In Affected Census Blocks (%) [2]	4.68%
In FEMA designated GIS Damage Zone	0.58%
FEMA Classification - Saturated	0.00%
FEMA Classification - Limited Damage	0.57%
FEMA Classification - Moderate Damage	0.01%
FEMA Classification - Extensive Damage	0.00%
FEMA Classification - Catastrophic Damage	0.00%

0. As of 10/31/2005
1. List of Places/MSA is not comprehensive. Based on Census places in affected areas.
2. Affected Blocks are identified by overlaying FEMA GIS maps of affected areas with Census GIS Block maps.